United States Patent

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[45] Patented **Aug. 24, 1971**
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Chicago, Ill.

[54] **AUTOMATIC AND MANUAL PLATING MACHINE**
10 Claims, 11 Drawing Figs.

[52] **U.S. Cl.** **134/46,** 134/58, 134/76, 134/83
[51] **Int. Cl.** **B08b 3/06**
[50] **Field of Search** ..... 134/46, 49, 58 R, 76, 82, 83

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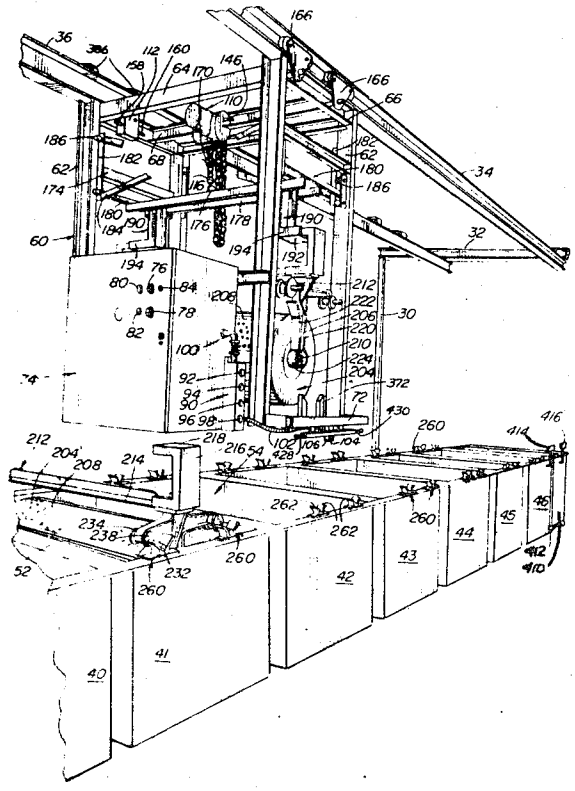
ABSTRACT: An electroplating machine adapted to move parts to be plated through one or more timed process steps sequentially or intermittently with either manual or automatic control as desired. In one embodiment, means are provided to sequentially engage, lift, convey, lower and release one or more baskets of parts to be plated through a series of metal preparation and electroplating baths. A longitudinally reciprocable carriage characterized by having a remotely controlled hoist, a cradle operated by the hoist to engage and disengage the parts baskets, which have means adapted to be engaged by the carriage and also alignment means for placing the baskets into their proper position in each treating tank. A control panel is also provided whereby the electroplater controls the machine through a series of manually operated switches or as desired can place the machine on fully automatic and closely timed operation. Included in the electrical control system are means to actuate the various timed movements of the hoist through a punched tape for completely controlled programmed and automatic operation so that each motion or cycle or combination is precisely repeated to insure uniform operation and results. Means are provided to sense the presence of a basket in a treating tank so that the hoist cannot place one basket on the top of another, to provide automatic shut-off or safety features in the system and to prevent undue wear of parts.



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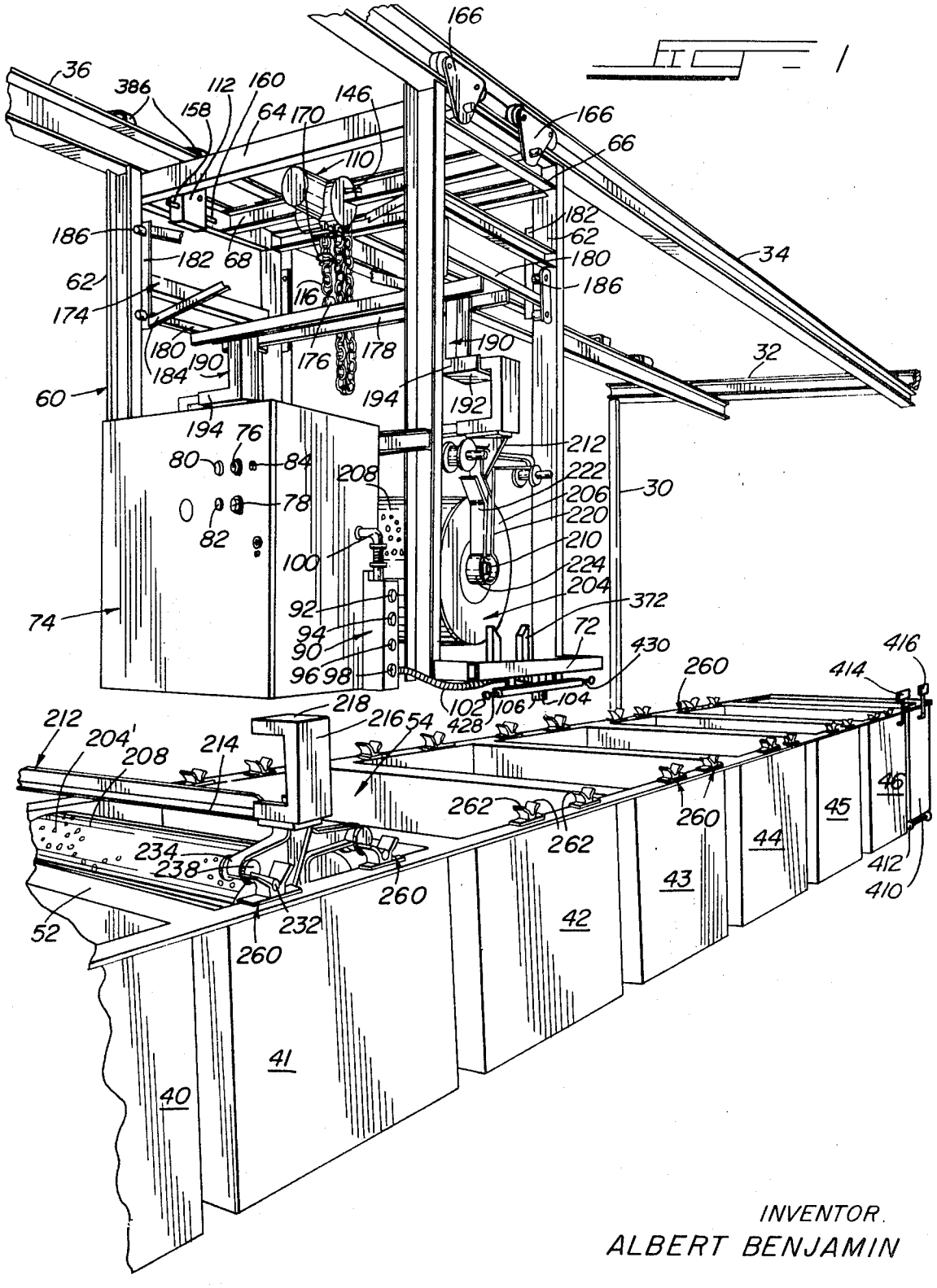

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FIG. 3

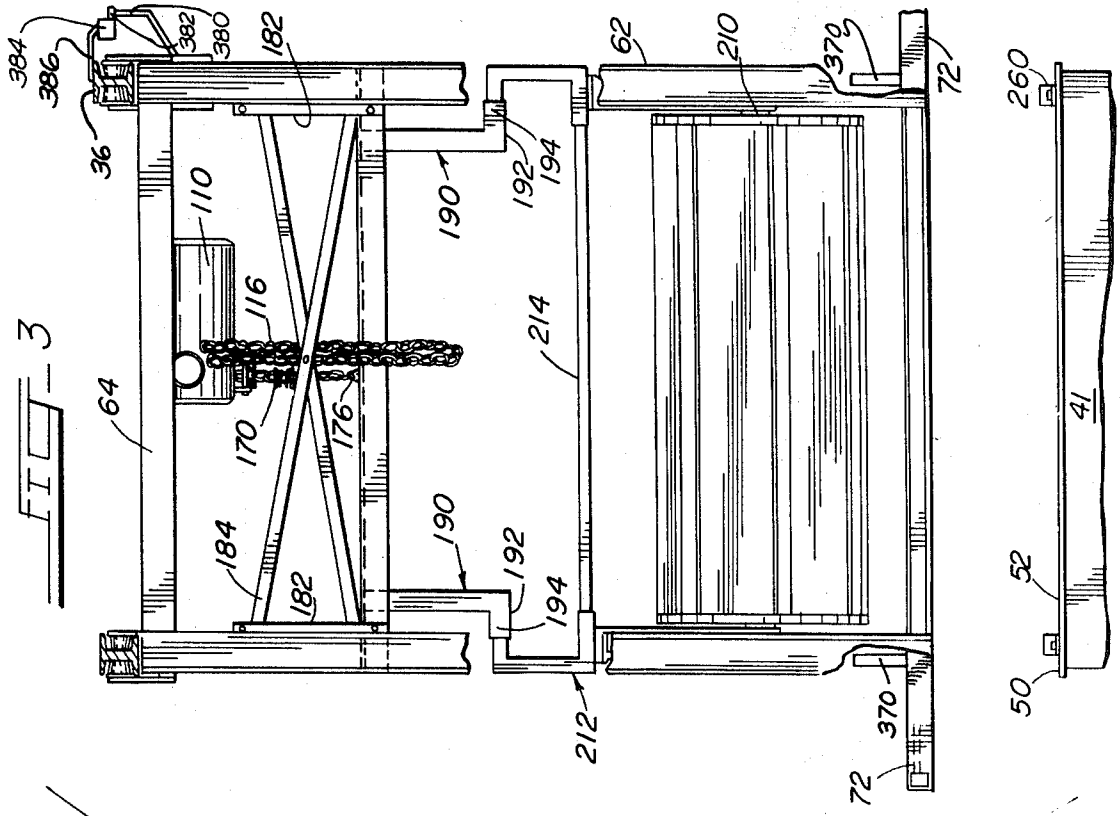

FIG. 2

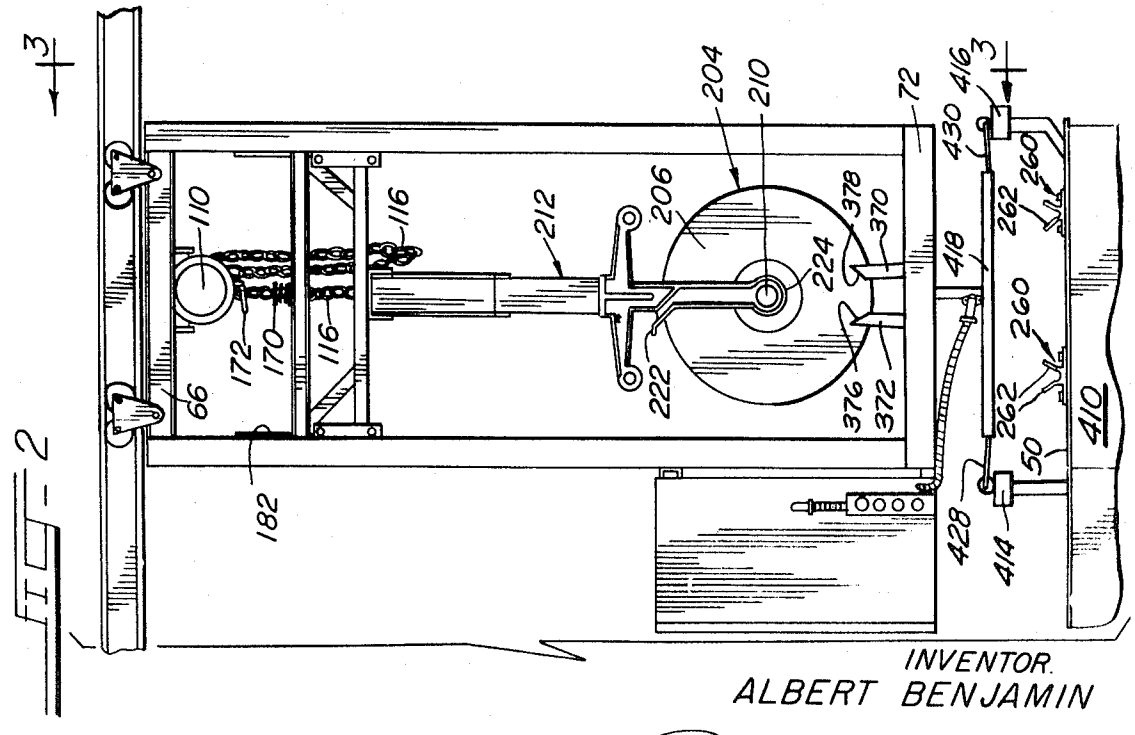

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FIG. 5

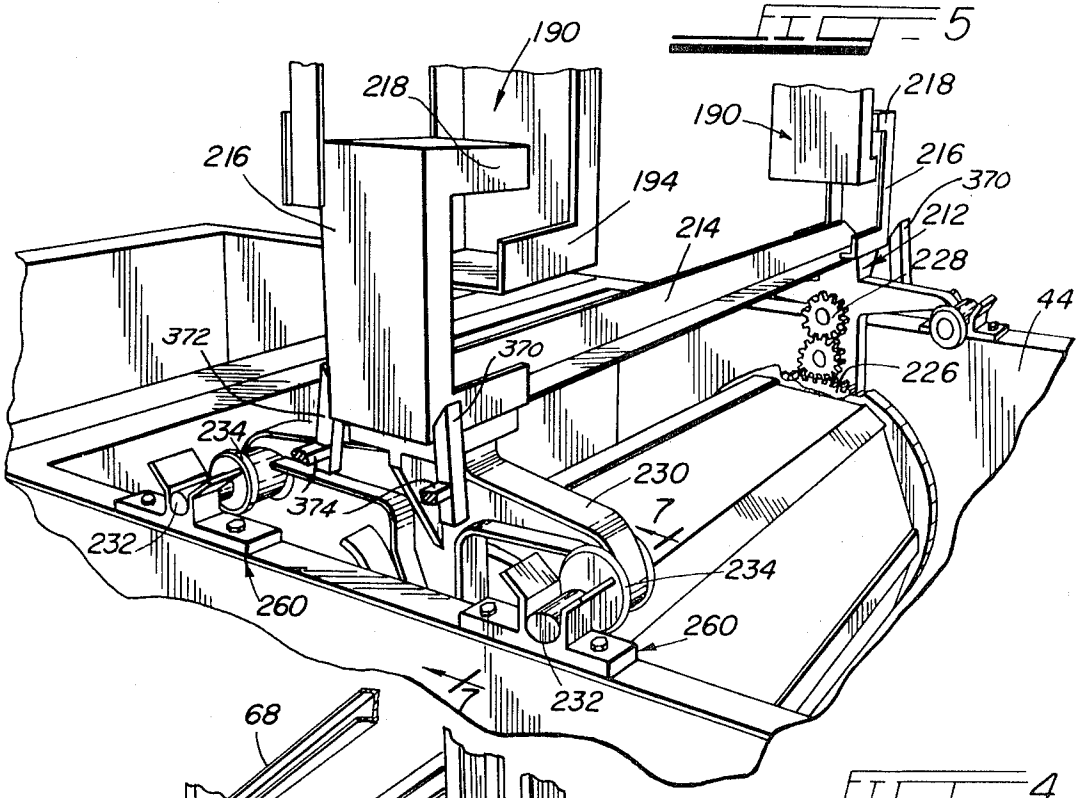
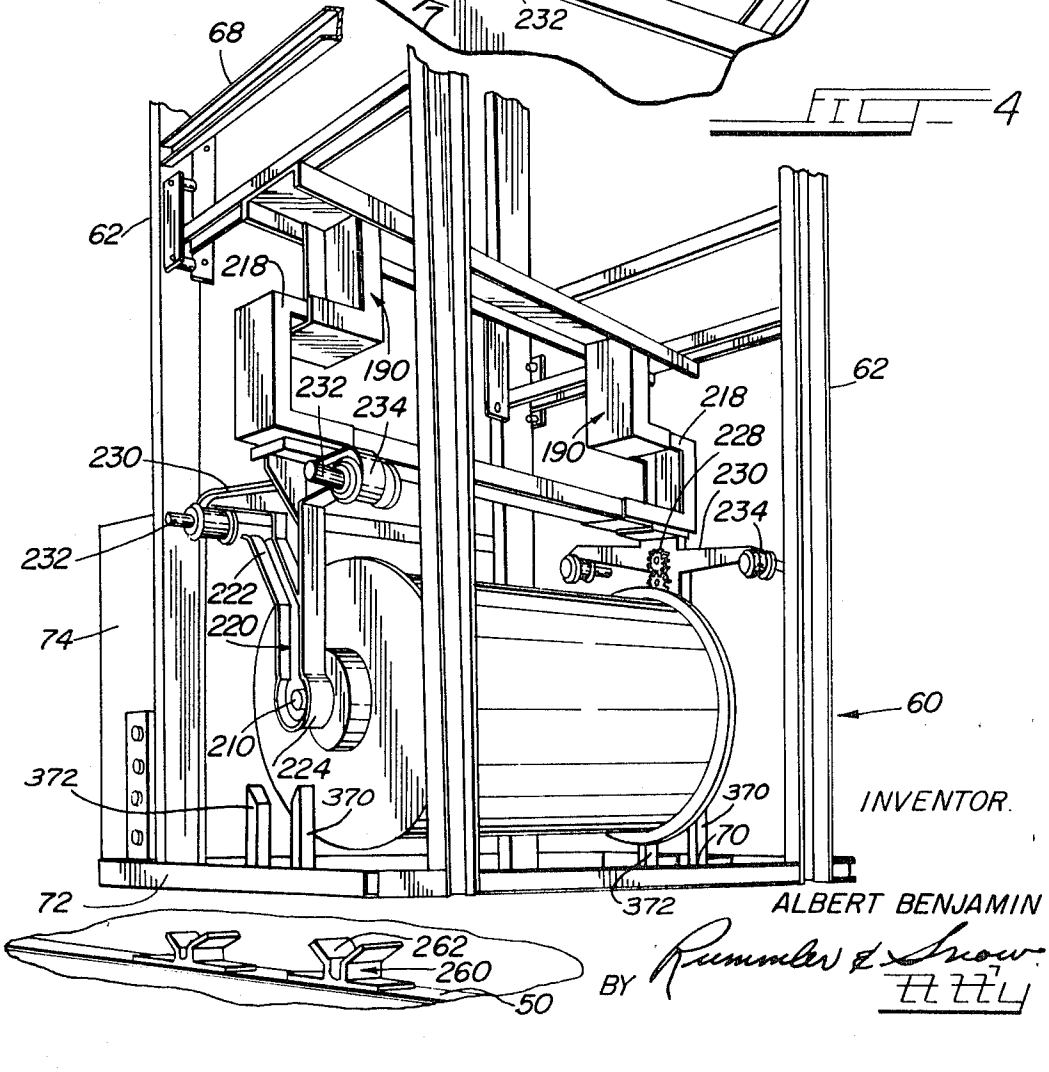


FIG. 4



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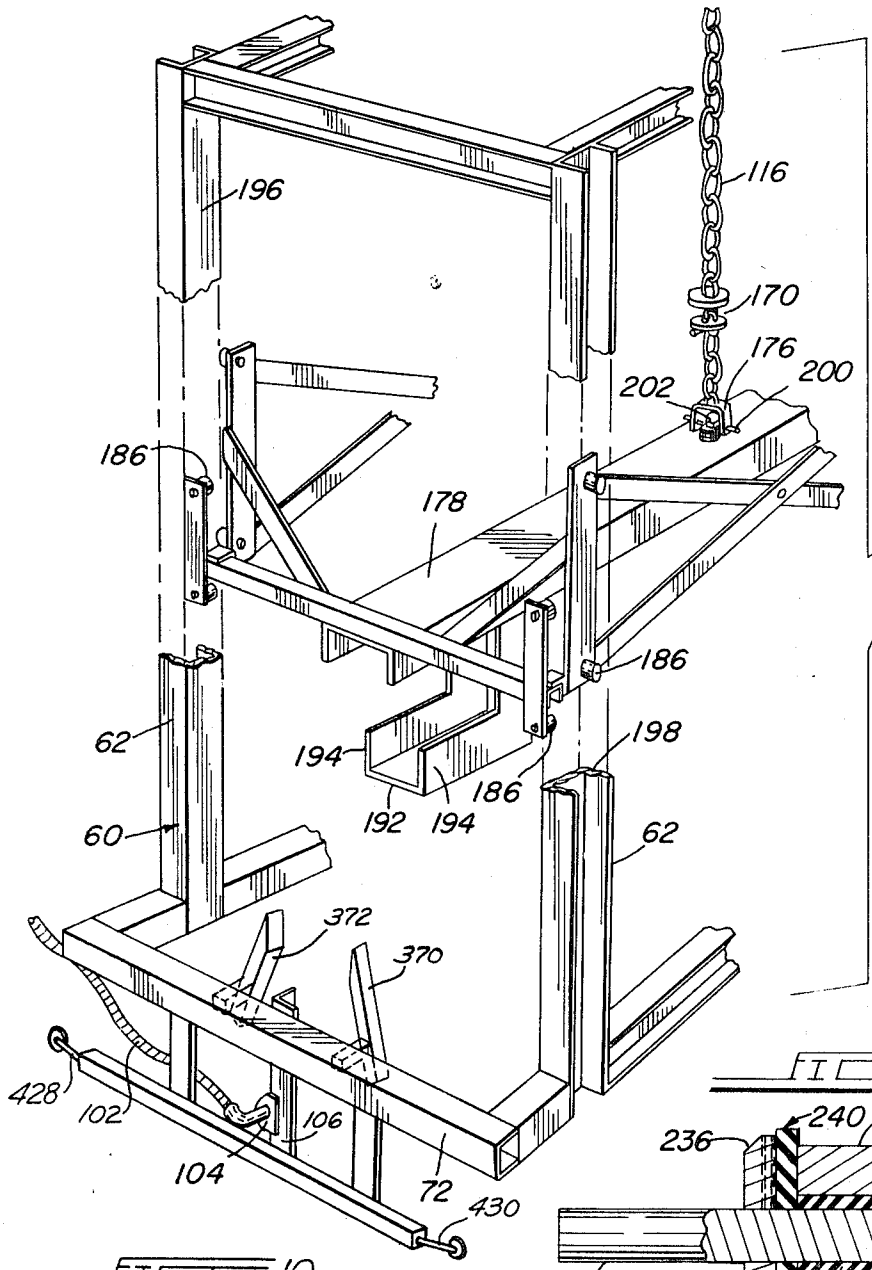


FIG. 6

FIG. 10

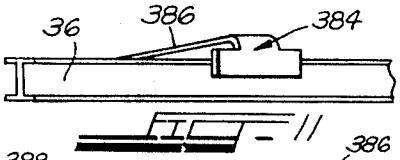


FIG. 11

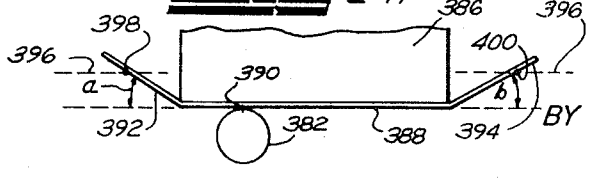
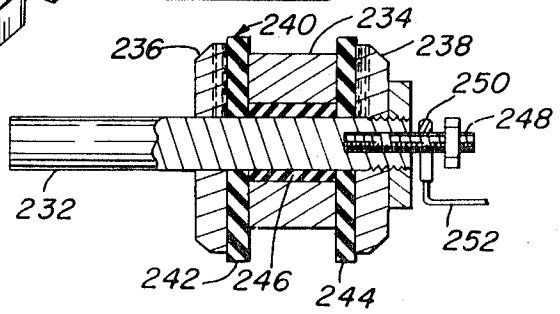


FIG. 7



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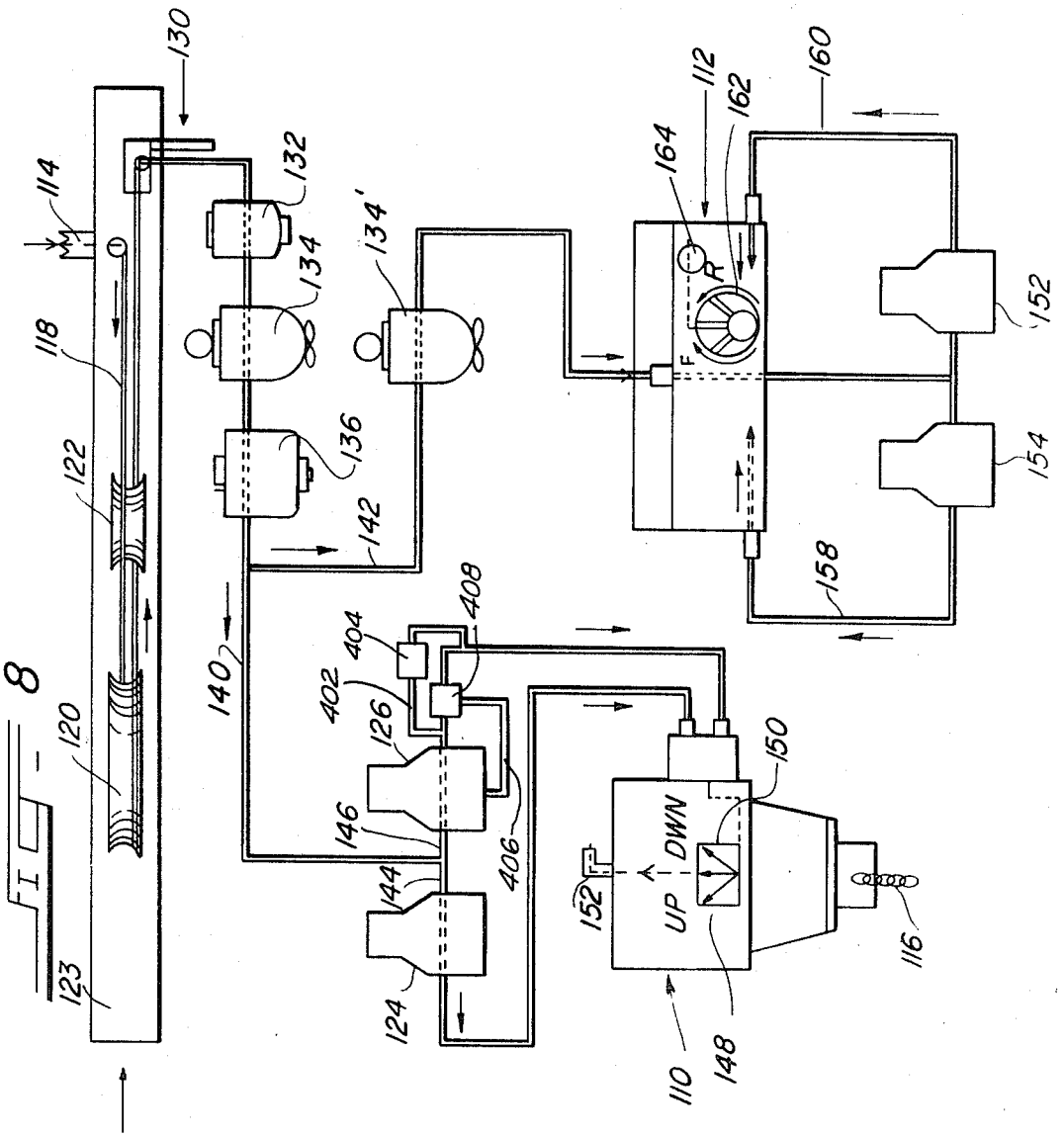

FIG. 8

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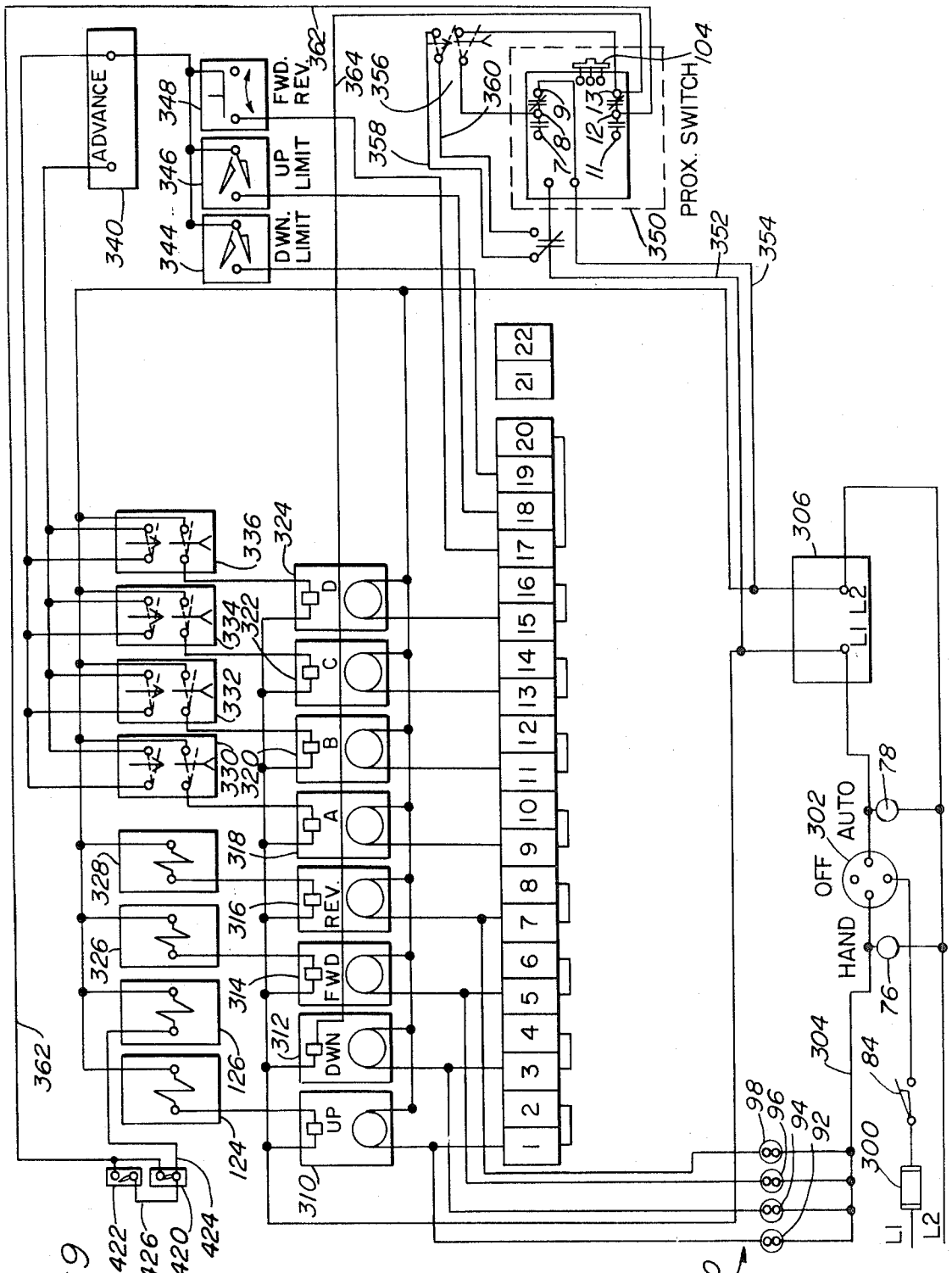

FIG. 9

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AUTOMATIC AND MANUAL PLATING MACHINE

BACKGROUND OF THE INVENTION

It is well known that protective metallic coatings of various nonferrous metals are applied to iron and steel parts to prevent or postpone corrosion from various causes and to enhance their appearance. These coatings are made of aluminum, cadmium, chromium, cobalt, copper, lead nickel, tin and zinc; and coatings of gold and silver are also used for ornamental purposes. Four principal methods are used for applying metal coatings, viz, hot dipping, cementation, spraying and electroplating. The hot-dip process is the earliest type known and is presently being extensively used. Electroplating is employed to an even greater extent in the application of coatings of nickel, brass, copper, chromium, cadmium, cobalt, lead and zinc.

The successful application of the hot-dipping and electroplating processes on a commercial basis involves basically the provision of optimum and effective metal preparation baths and essentially critical timed control of the electroplating or dipping baths through which the part or parts are moved. The electroplater, for example, must be certain that the metal parts are properly prepared before the plating step through the application of treating solutions designed to remove organic matter, such as oil or grease, inorganic matter, such as scale or rust and, in some instances, are electrolically cleaned or pickled. He must control the effectiveness of the metal preparation or cleaning solutions by replacement or replenishing when they become dissipated or otherwise lose their utility and at the same time control the length of time in each treating tank so that maximum utilization is made of the equipment and production is maintained at a high level. Likewise, the precise control must be had over the electrochemical reaction taking place in the plating tank with such variables as time, temperature, voltage and cathodic concentration requiring constant surveillance. Where a great number of parts are being processed simultaneously through a system, such as in barrel-plating, it is essential that the parts be maintained in continuous motion so that they tumble over each other and present successively all parts of their surfaces to the electroplating action of the current. These process conditions and time cycles must sometimes be varied to take into account the number, kind, shape and condition of the parts to be plated, the condition of the various baths and the final level or type of plating desired, which variations should not interrupt the plating process or require unduly complicated manipulations or procedures on the part of the electroplater.

The instant invention is directed to an electroplating machine which is adapted to conduct parts to be plated through the series of successful steps under precise control at or approaching the capacities of treating baths with a minimum of attention by the operator, whereby each step, motion or cycle is performed and repeated in exactly the same manner and conditions so that the plated parts meet the established standards of appearance, uniformity, hardness, etc. A feature of this invention is the provision of a tape-operated electronic control system for automatic operation of a plating machine with provision for manual override and manual control at any point during the operation.

SUMMARY OF THE INVENTION

The invention concerns a plating machine characterized by one or a combination of the following:

1. Precise tape-operated electronic control for fully automatic operation of all sequences of events, with selective programming as desired;
2. manual override and manual control at any desired time during automatic operation;
3. finite adjustment of time sequence or occurrence sequence of the events taking place in the process;
4. means to engage, raise convey, lower and release one or more parts baskets through a series of treating tanks in timed sequence;

5. means to sense the presence of a parts basket in a given treating tank so as to prevent the placement of another parts basket thereon;
6. means to insulate the parts baskets individually from the treating tanks and conveyor means;
7. automatic safety shut-off means within the conveyor system;
8. means to maintain constant tension on control conduits and hoses and the like to prevent undue wear or breakage;
9. means to align the parts baskets in the treating tank saddles and release the baskets at the end of the process line.

DESCRIPTION OF THE DRAWINGS

Specific embodiments of this invention are shown in the drawings wherein:

FIG. **1** is a fragmentary perspective view of the device of this invention shown in operable relationship with a pair of parts baskets and a series of treating tanks;

FIG. **2** is a fragmentary side view of the conveyor and parts basket handling system, showing a parts basket in raised position, one position of the electronic control cabinet, the sensor, and final release means in relation to the treating tanks and conveyor dolly;

FIG. **3** is a fragmentary end view taken along the lines **3—3** of FIG. **2**;

FIG. **4** is a fragmentary perspective view showing the parts illustrated in FIGS. **2** and **3**;

FIG. **5** is a fragmentary perspective view showing the relationship of the parts as the conveyor system has released, is about to engage, or is passing by a parts basket located in a treating tank;

FIG. **6** is a fragmentary perspective view showing the details of construction of parts of the conveyor system;

FIG. **7** is a cross-sectional view taken along the lines **7—7** of FIG. **5** to show the construction of the insulating mount for the basket hangers;

FIG. **8** is a schematic plan view of one form of automatic hose tensioning means that can be used with this invention;

FIG. **9** is a circuit diagram to illustrate the electronic, tape-operated control system for the device of this invention;

FIG. **10** shows a perspective view of the target control for the conveyor; and

FIG. **11** shows a plan view of the target control for the conveyor.

THE PREFERRED EMBODIMENT

Referring to FIG. **1** the general arrangement of the parts is shown wherein a series of spaced floor-mounted upright support members **30** and suitable cross beams **32** form a framework to which is attached the pair of elongated parallel I-beams **34** and **36** which extend any desired distance in line with and spaced above a series treating tanks indicated at **40–46**. The tanks are constructed of sheet metal of suitable alloy composition externally and internally, or are provided with chemically resistant liners, to function as containers for the various treating solutions, solvents, electrolytic baths, electroplating solutions, and finishing or washing solutions required for the electroplating or hot dip process. The treating tanks are provided additionally with the necessary auxiliary control equipment (not shown) to maintain the required process conditions, including plating potential, volt meters and potentiometers on those tanks wherein the electroplating, for example, takes place. One or more adjacent or separate tanks in the series can contain the same or different solutions, viz, two tanks may contain degreasing solvent or two tanks may be electroplating tanks so that more than one series of the same or different plating operations can be performed substantially simultaneously, as desired. For purposes of illustration, the tanks will be presumed to perform the following functions: tank **40**, degreasing; tank **41**, alkali salt solution; tank **42**, electrolytic cleaning; tank **43**; pickling; tank **44** electroplating and tanks **45** and **46** finishing and rinsing.

Each of the tanks 40–46 has a flanged side lip 50 and an end lip 52. The tanks can be individual units placed in aligned positions as shown or may be semiunitized i.e., attached to each other by suitable means. The weight of the tanks maintains their respective position to the framework and the spacing between the tank interiors 54 is uniform. Preferably, the tanks are substantially the same size and capacities for economy of construction, uniformity in operation and interchangeability. The flanges 52 can serve to maintain substantially equal spacing, center-to-center, along the series of treating tanks.

The framework and I-beams 34–36 support a crane 60 of the underhung traveling gantry type which is characterized by a box framework including the upright members 62, the cross members 64, the longitudinal members 66 at the top, suitable cross braces 68 and the corresponding bottom members 70 (FIG. 4), with a guard rail 72 on the operator's side to prevent mishaps. The crane 60 carries the control box 74 having selector switches 76 and 78 and indicator lights 80 and 82 extending from a "HAND" or "AUTO" switch on the inside of the cabinet 74. The main "ON" and "OFF" switch to control the entire electrical circuit therein is indicated at 84. The cabinet 74 also carries the manual pushbutton switch 90 having, respectively, the "UP," "DOWN," "FORWARD," and "REVERSE" buttons 92, 94, 96 and 98 extending in convenient relationship for the operator. The electrical conduit therefor is shown at 100, along with the conduit cable 102 and sensor 104 supported by the angle iron support 106, the function of which is to be described.

Referring to FIG. 8, the hoist 110 is shown along with the tractor 112 both of which operate from the source of power 114. A preferred type of hoist is the Air-Bloc hoist, type LC 5, (Ingersoll-Rand operating on compressed air from the source 114 and capable of imparting a controlled lifting and lowering action to the welded link chain 116. The preferred type of tractor is the air motor driven tractor for overhead hoists (SIZE TVH 50A) by Ingersoll-Rand. The hoist 110 can be any type of hoist other than the type illustrated as long as it can be remotely controlled electrically or pneumatically and has a capacity sufficient to handle heavy loads viz 1,000 lbs., or more, and preferably is explosion proof. The same considerations apply to the tractor 112.

Instead of using a pendent throttle with this hoist it is connected by means of the traveling air hose 118 operating on sheaves 120 and 122 supported by the frame member 123, through a pair of three-way solenoids 124 and 126, the functions of which will be explained in relation to FIG. 9. The sheaves 120 and 122 allow the air hose 118 to move longitudinally back and forth and also extend and shorten with the up and down movements of the hoist while maintaining proper tension on the hose and prevent kinking, breaking and undue wear.

The air hose is connected through the bracket 130 to the float drain filter 132 wherein any debris or moisture is removed, to the pressure regulator 134 and finally to the lubricator 136 wherein the air picks up a mist of oil for at least partial lubrication of the working parts of the hoist 110 and the tractor 112 and also to leave a corrosion-resistant coating on these working parts.

The air supply 114 leaving the lubricator 136 branches into lines 140 and 142. The line 140 has the branch lines 144 and 146 controlled by the solenoid valves 124 and 126, respectively, while the branch line 142 conducts the compressed air through the regulator 134' to the air tractor 112. The air hoist 110 has an "UP" limit switch 148 and the "DOWN" limit switch 150 shown schematically and the air exhaust is shown at line 152. Similarly, the air tractor 112 is controlled by the three-way solenoid valves 152 and 154, the former for reverse and the latter for forward operation through the branch lines 158 and 160, respectively. These operations are further controlled by the limit switch 162 (forward and reverse) shown diagrammatically. The exhaust for the tractor is shown at 164.

The relative positions of the Air-Bloc hoist 110 and the air motor driver tractor 112 on the crane 60 are shown in FIG. 1. One side of the crane 60 is carried by the trolleys 166 having the inner trolley wheels 168 riding on the flange of the I-beam 34. The tractor 112 is constructed as part of the frame member 66 on the other side of the crane 60 and has its own four wheel trolley with a solid neoprene drive wheel operating against the bottom of the I-beam 36. Only one tractor motor is necessary for proper back and forth movement of the crane.

The traveling end of the chain 116 has a safety limit bumper 170 adapted to shut off the air motor hoist 110 if the chain travels upward against the housing of the hoist by impingement against the safety stop lever 172 (see FIG. 2) which controls the flow of compressed air in line 140 by means of a valve (not shown) overriding the solenoids 124 and 126. The chain 116 is affixed to an inner movable carriage 174 by means of the yoke 176 (FIGS. 1 and 3) or other suitable attachment to the inverted U-beam 178. The beam 178 has the cross members 180 attached to its outer ends which by means of the uprights 182 and cross braces 184 hold the guide rollers 186 in rolling contact with each of the upright members 62 of the crane 60. The beam 178 has an L-bracket 190 at each end with a lower horizontal outwardly extending arm or catch member 192 having the spaced retainer sidewalls 194 forming a recess therebetween. Through the up and down operation of the hoist 110, as controlled by the solenoid valves 124 and 126, the inner carriage 174 is adapted to move up and down within the crane 60, guided against lateral movement by the rollers 186. At the same time the tractor 112 is adapted to move the entire crane assembly 60 and control box 74, through the operation of the solenoid valves 152 and 154, back and forth along the rails 34–36 above the tanks 40–46, all movements being under precise control and in timed sequence.

Referring to FIG. 6, the relationship of these parts and further details of construction are shown wherein the rollers 186 are arranged to engage, at each corner beam 62 of the crane 60, an inner guide surface 196 and a side guide surface 198 of these beams so that the inner movable carriage 174 is supported against movement in two directions and thus assumes a straight line up and down movement within the crane. Also the yoke 176 and its manner of attachment to the cross pin 200 engaged by the bolt 202 affixed to the inverted U-beam 178, are shown in more detail.

In FIG. 1, the crane 60 is shown with the inner carriage 174 in lifting or holding engagement with a parts basket 204, which may represent the crane in the process of transporting the parts basket longitudinally in either direction along the tracks 34–36 or in a stopped position having just removed the parts basket from one of the tanks such as tank 42 or in a position for lowering this basket into the tank 42. Another basket 204' is shown in the tank 41. These baskets are shown to have a cylindrical configuration but may be any desired shape or have open tops. The baskets have end walls 206 and cylindrical sidewalls 208 which may be in the form of a perforated screen through which the various cleaning and electroplating solutions are free to pass. Each basket in process will contain a part or parts (not shown) to be electroplated.

The opposite end walls 206 of the baskets have short supporting shafts 210 extending axially therefrom which are engage by individual basket hangers 212 comprising T-beams 214 having an upright U-beam hook 216 at each end. The upper part of each hook 216 has an inwardly directed leg 218 which is positioned and so dimensioned such as to be engageable within the recess defined by the walls 194 of the catch members 192 of the L-brackets 190. Each hanger 212 has a U-shaped spring arm 220 with offset leg 222 for passage of electrical conduits, i.e., ground wires (not shown) which are affixed to the baskets, as during electroplating, etc. The spring arms have a bearing collar 224 which rotatably encompasses the shafts 210. Means are provided (FIG. 5) for rotation of the baskets while immersed in a tank 44, to include the ring gear 226, and drive gear train 228 which is driven by a self-contained motor (not shown), which is mounted on the tanks 40–46 supported by one end of the hanger 212 for each basket.

Affixed to a part of the basket hanger assembly is a pair of cross arms **230** having at their extended ends the support shafts **232** carried by means of the journals **234** (FIG. 7) at the ends of the arms. Each shaft **232** has spaced collars **236** and **238**, (outer and inner respectively) with an insulator **240** having the flanges **242** and **244** and an inner collar or sleeve **246** between the shaft parts and the cross arm. As shown in FIG. 7 a bolt **248** is provided in the end of one or more of the shafts **232** with a washer **250** connected to the lead conduit **252** for purposes of the necessary electrical connections to accomplish the electroplating, i.e, making the baskets cathodic in the system. Other insulator means can be used for the shafts **232**.

The top flanged edge **50** (FIG. **1**) of the tanks **40–46** have, at each side, a pair of spaced journals or saddles **260** with diverging opposed ear members **262**, providing a channel to receive the extended end of each shaft **232**. The journals are aligned side to side on each tank and spaced so as to engage the pairs of shafts **232** at each end of the hangers **212** as the baskets are lowered into the tanks. Once in place the baskets do not touch the insides **54** of the tanks and are properly contained therein so that the parts are in intimate contact with the treating solutions. As shown in FIGS. **1** and **5**, the hangers **212** remain with the parts baskets at all times.

Referring to FIG. **9**, the electronic control and timing circuit is shown, all of which is contained within or upon the control box **74**, except the sensor **104** which is located on the bracket **106** on one side of the crane **60**. This circuit will be described generally with only limited reference to the various lead wire connections, since once the types and functions of the main components are made clear, they may be connected in other ways to accomplish the same results. Those parts which correspond to parts already described will bear the same reference numbers.

The 115 v. power source is indicated at **L1** and **L2**, the former being connected through the fuse **300**, to the main switch **84** and thence to the "HAND" and "auto" switch **302** which is normally in "OFF" position and is regulated by the pushbuttons **80** and **82**, which have the corresponding indicator lights **76** and **78** to show the type of control being called for by the circuit. The button **80** connects the power source through the line **304** to the manual pushbutton switch **90** having the "UP" button **92**, "DOWN" button **94**, "FORWARD button **96** and "REVERSE" button **98**. The line L2 connects to one side of the indicator lights **76** and **78** to the L2 barrier terminal box **306** and the line L1 comes from the "AUTO" side of the switch **302** to the barrier terminal L1. It is thus seen that with the switch **302** in "HAND" position, the light **76** is "ON " and the manual pushbutton switch **90** is connected in the circuit and with the switch **302** in "AUTO" position the power source is switched to the barrier terminal box **306**. The balance of the circuit includes the brush channel output leads indicated at **1–20** inclusive, the contact roller leads **21** and **22**, the contactors **310** to **324**, the solenoids **124**, **126**, **326** and **328**, the timers **330** and **336**, the advance **340**, the down limit switch **344**, up limit switch **346** and forward and reverse limit switch **348**. It is noted that the sensor **104** is connected to the proximity switch **350**, which is connected across the terminals L1 and L2 by means of the lines **352** and **354**, in conjunction with the timer **356** intercepting the line **352** by lines **358** and **360** and that the line **362** connects therefrom the "down" solenoid **126**, with the line **364** connected to the "down" contactor **312**.

The brush channel output leads and the contactors are parts of a tape operated timer having a series of reading brushes which are held with their tips in contact with a punched tape carried by a contact roller electrically connected to the various contactors **310–324**. The tape has a series of punched holes therethrough which allow the reading brushes to be placed into contact with the contactors as the tape revolves on the roller. The brush passes sequentially from a read mode to a transfer mode by means of an advance impulse sent from the down limit switch **344** or the up limit switch **346** or the forward and reverse limit switch **348**.

The proximity switch **350** may be of the relay type operable through the sensor **104** when a metal part comes within a certain detection range and releasing when the metal part is outside of or leaves the detection range. A product manufactured by MICRO SWITCH, a division of Honeywell, using a type 6FS1 sensor, a type 60 FL1 amplifier having a ½ inch sensitivity is suitable for this purpose. Such a device requires 105–130 VAC at 60 cycles and has a response time of **35–50** milliseconds to operate and 35–60 milliseconds to release.

Whenever brush channels **3, 4** are punched for down travel, a proximity switch simultaneously activated which makes operable a sensor head mounted on the hoist superstructure. The sensor head will react immediately to metal when in detection range. The head is so mounted as to be in range of the bracket of a barrel cylinder when in the saddles of a station where the down operation is to take place. If a barrel cylinder is accidentally in a station where the program has instructed the hoist to move down, then the sensor head responds and, through the proximity switch, cuts the electrical circuit to the down solenoid thus stopping the unit. The hoist will remain in this position until the offending barrel cylinder is removed. This is done by changing the system to manual and removing the barrel cylinder, placing it in its proper station, and returning to the position at which the hoist originally stopped.

Changing back to automatic will start the hoist down and with the sensor head once again activated, not responding to metal not present, will continue its downward motion followed by normal operation as explained elsewhere. It is to be noted that the descending barrel cylinder has a bracket which in its downward motion will pass before the sensor head. This would stop the hoist as previously mentioned, but is avoided by the proximity switch being activated from the down contactor through an automatically resetting clock which times out and deenergizes the sensor head before the cylinder barrel bracket passes near the sensor head.

The operation of the device is as follows: Assume that the process calls for the following events **1**) passage of the baskets into and from each of the treating tanks for 1.5 minute intervals and that the parts basket **204'** has completed its treatment in tank **40** and has just been placed in tank **41** for rust removal. Also that basket **204**, presently in the crane, is scheduled for treatment in the tank **40**.

The operator sets the switch **302** to "HAND" and using the manual pushbutton switch, moves the basket **204** into the tank **40**. Once lowered into the tank a momentary touch of the "-FORWARD" or "REVERSE" buttons moves the basket cradle **174** and the arms **190** out of registry with the basket hangers **212** and the cradle can be moved to engage the basket **204'** and move it to the tank **42**. Without automatic timing, the operator may use his chronometer to time the instant when the basket **204** is removed from the tank **40** and placed in the tank **41**. Gradually, the two baskets are moved in this way from tank to tank to complete the process.

If automatic operation is desired, the operator sets the tape in the punched tape programmer i.e., a model **222** timer as manufactured by Industrial Timer Corporation and moves the switch **302** to "AUTO " position. As the brush channel output leads pass through the series of punched holes on the tape, the contactors for "UP" and "DOWN" movement, etc. controlling the solenoid valves **124** and **126** etc., are actuated along with the sequence timers **330–336** so that each step is controlled automatically.

During each cycle as a parts basket is to be lowered in a tank the brush channel **3**, for example, conducts through the contactor **312** and actuates the solenoid **126** for down movement of the air tractor **110**, carrying the carriage **174** past the release point of the U-beam hooks **216**, at which point the down limit switch cuts in through the channel output **19** to stop the downward movement. Next the forward brush channel **5** conducts through the contactor **314** and the solenoid **326** is activated causing the tractor **112** to carry the carriage **174** to the next tank to engage the parts basket therein, scheduled for removal. Any schedule can be punched on the

tape in the programmer to accomplish the desired treating cycles.

In one embodiment of this invention guide means are provided to align the support shafts **232** on each end of the basket hangers **212** with the saddles **260** on the treating tanks. For this purpose, the guard rails **77** on each side of the crane **60** have a pair of guide arms **370** and **372** affixed on the inside by means of the brackets **374** and held in upright spaced relationship. The guide arms **370** and **372** have downwardly and inwardly beveled and opposing ends **376** and **378**. The guide arms are spaced from each other a distance slightly greater than the width of the hooks **216** so that as the parts basket descends they pass against and center the basket and hanger over the treating tank with the shafts **232** over or in registry with the saddles **260**. The guide arms **370** are positioned so as to pass between the shafts **232** and are spaced wider apart or taper outwardly at the bottom (FIGS. **2** and **6**) so that the hangers are guided in their upward path also and do not catch on the guide arms when the parts basket are raised. The guide arms are slightly wider spaced from each other at the bottom than top so that they present camming surfaces against the basket hangers **212**.

There is little or no difficulty in properly aligning the baskets with the treating tanks on the descent cycle since the saddles **260** automatically align the baskets within the tanks. Difficulty was had in raising the baskets because of being carried up off-center. The centering guide arms **370** and **372** have solved this problem of override and underride, i.e., attaining exact centering during the pickup cycle. As the basket ascends the guide arms pass against the offcenter hooks **216**, on either end, and move the leg **218** into the center of the catch members **192**, i.e., between the sidewalls **194**.

The control **380** for the forward and reverse limit switch **348**, carried by the tractor **112** is shown in FIG. **3** with a roller contact **382** in contact with the target **384** affixed to the I-beam **36** on the back side of the device by means of the bracket member **386**. A target **384** is provided along the I-beam **36** for each tank or station as partly shown in FIG. **1**. If the hoist **60** is to move two tanks then the fifth channel on the tape is punched twice and the limit switch must be activated twice by the two targets.

The pneumatically operated drive **112** is characterized by having a different stopping distance depending on its direction of travel. In one direction with a given type of motor this distance may be 2½inches while in the other direction it may be 1½ **inches of travel along the I-beam before a complete stop is accomplished. It is important that the hoist be stopped and started from the exact same point over each treating tank. To accomplish this the target** 384 **is specially shaped as shown in FIGS.** 10 **and** 11. **The target** 384 **has a planar midsection** 388 **with the stop point of the roller contact** 382 **shown at** 390 **to illustrate, and a pair of tabs** 392 **and** 394 **over which the roller must pass as the hoist** 60 **moves to that position on the track** 34–36. **The path of the roller is illustrated by the dotted line** 396 **and the points** 398 **and** 400 **represent the positions on the tabs where the roller contacts same and is moved outwardly to trip the limit switch** 348. **Each tab is bent to form a cam surface; tab** 392 **intercepts the plane of the midsection at an angle** "*a* " *which is about* 05° and the tab **394** intercepts the plane of the midsection at an angle "*b*" which is about **21°** . The linear travel distance of the roller **382** from the point **398** to the point **390** is the stopping distance of the motor **112** from that direction, which to accommodate the example is 1½. The linear travel distance of the roller **382** from the point **400** to the point **390** is the stopping distance of the motor **112** from the other direction or 2½''. Thus, the hoist **60** stops at the point **390** from either direction.

In another embodiment of this invention, means are provided to control the speed of downward travel of the hoist so that during the last increment of downward movement the hoist is slowed down so that the baskets are placed in the treating tanks without dropping or banging and the shafts or horns **232** engage the saddles **260** with little or no impact. This is accomplished by providing the bypass line **402** and the speed control valve **404** in the air line **146**, following the solenoid valve **126**. The pilot air line **406** connects from the solenoid valve to the speed control valve **126** to the air actuated solenoid clock **408**. When the solenoid **126** is actuated, the air passes through the air clock **408** and at the same time air passes through the pilot air connection **406** to the clock portion of the air clock solenoid. When the clock times out, it closes the line **146** and the only air through the system passes through the line **402** through the speed control valve **404**. The valve **402** has a much smaller air passage and reduces the flow to the air motor **110**, causing it to run slower and set the parts baskets down gently.

In addition to the sensor **104**, the device of this invention includes means to prevent a basket from being deposited at the last step of the cycle unless a secondary conveyor or receptacle such as the dolly **410** is in place. The dolly **410** represents any means of conveying a parts basket from the electroplating machine after it has been processed through the treating tanks. The dolly runs on the tracks **412** and, for purposes of illustration, is a walled receptacle to hold a cylindrical parts basket **204** and provide easy handling. A similar arrangement (not shown) can be provided in front of the tank **40** so that baskets of parts can be transported to the plating machine. As shown in FIG. **2**, the dolly **410** has a pair of saddles **260** at each end to support the baskets.

The last tank **46** has a target or flag **414** extending from the flanged rim **50** by a suitable bracket and the dolly **410** has a similar target or flag **416** extending from its far corner. As shown in FIG. **2**, the flags **414** and **416** extend upwardly in the plane of the bracket **418** which serves as a housing and support for two microswitches **420** and **422**, (see FIG. **9**) connected in line **362** by means of the electrical leads **424** and **426**. The actuating arm for the microswitch **420** is shown at **428** (FIGS. **1**, **2** and **6**) and the actuating arm **430** controls the microswitch **422**. The switch **420** is normally closed while the switch **422** is normally open. The flags are positioned so as to come into contact with the actuating arms **428** and **430** only when the crane **60** is in the last position over the secondary conveyor represented by the dolly **410** as shown in FIG. **2**. The purpose of the switches is to prevent the lowering of the hoist **110** unless the dolly is present. The target **414** is stationary and is located on the treating tank of the next to last station. When the hoist reaches the last station (over the track **412**) and begins to lower the parts basket, the arm **428** strikes the flag **414** and the normally closed microswitch **420** is activated to open position and the circuit to the down solenoid **126** is cut off. If the dolly is not present the hoist stops in this position. The operator can switch to the manual control switch **90** if desired. With the dolly present the arm **430** is actuated and the normally open microswitch **422** is closed, thus by passing the open switch **420** and the hoist continues to lower the parts basket into the dolly. By having both the arms **428** and **430** and the flags **414** and **416** located so that the contacts are made simultaneously, —the operation of the hoist is continuous, though still under the control of the speed control valve **404** and the solenoid clock **408**.

The material handling device of this invention can move one container successively through the various process stations represented by the tanks **40–46** with or without the release of the hanger **212** from the carriage **17**. More than one container of parts can be in process at any one time and one or more empty tanks can be used as holders for the container or parts baskets **204** as parts are being placed therein. The engaging means between the carriage **174** and the hanger **212** can be of any type which is adapted to engage through vertical and horizontal movements of the carriage. True lineal movement without side sway or swinging of the heavy parts basket is assured by having the hook and catch members present flat opposing surfaces to one another. A single support shaft **232** can be used instead of a pair.

Normally, the exhaust ports **152** and **164** would be equipped with snuffers (not shown) of the Burgess Manning

type. Also insulated copper rods may be provided in the brackets **216** and similar connections provided between the shafts **232** and the saddles **260**, so that the hoist of this invention can be used for rack plating or processing as well as barrel plating. By these means, larger parts can be affixed to the hangers **212** and used without the baskets as a roll plating machine. The control box **74** can be located at any convenient place on the apparatus.

Other modifications of the invention that are within the scope thereof will become apparent to one skilled in the art.

What is claimed is:

1. A material handling system adapted to sequentially convey a container holding said material along a series of process stations comprising:

a. track means extending along and above said stations;

b. a trolley frame adapted to roll along said track means, in spaced relationship with said stations;

c. a first motor means to move said trolley frame in forward and reverse directions along said track means;

d. a carriage slidably supported on a substantially vertical axis within said trolley frame and over said stations;

e. a second motor means to reciprocate said carriage within said trolley frame;

f. means on said carriage to engage and disengage said container through vertical and horizontal movements of said carriage;

g. means to control said first and second motor means whereby said carriage and engaging means are movable in sequence to engage said container and convey same successively to said stations whereby said material is treated to the process of each station;

h. said container comprising a cylindrical housing having a perforated wall and oppositely facing axle means at each end;

i. said stations comprising a series of open-topped process tanks containing liquid treating agents and adapted to receive said container therein;

j. a hanger member for said container having a pair of bearing collars engaging said axle means and a transverse yoke member across each end;

k. said yoke members having journaled ends supporting fixed stub shafts extending substantially parallel to and spaced from the periphery of said housing; and l. said process tanks having means to receive said stub shafts and thereby suspend said cylindrical housing by said hanger member in said tanks.

2. A material handling system in accordance with claim **1** in which:

a. said track means comprises a pair of elongated substantially parallel track members supported over and spaced above said stations;

b. said stations comprise a series of open-topped process tanks adapted to receive said container;

c. said trolley frame includes an upright guide member aligned along the vertical axis of said carriage; and

d. roller means between said upright guide member and said carriage whereby said container is movable into and out of said process tanks by said second motor means and is movable in elevated position from one process tank to the other by said first motor means.

3. A material handling device in accordance with Claim **1** in which:

a. said first and second motor means comprise air driven motors;

b. a source of compressed air connected through conduits to said air driven motors;

c. valve means in said conduits to control the forward and reverse motions of said first motor;

d. valve means in said conduit to control the reciprocation motions of said second motor;

e. said control means including a control circuit for said valve means;

f. brush channel contactors in said circuit in operable relationship with a rotating relationship with a rotating constant speed drum; and

g. a punched tape carried by said rotating drum in operable relationship with said contactors whereby the sequential movements of said carriage and engaging means are accomplished.

4. A material handling system in accordance with claim **3** including:

a. a forward and reverse limit switch to control the flow of compressed air to said first motor means, and carried by said trolley frame;

b. an actuating arm on said forward and reverse limit switch;

c. a target member along said track means positioned above each of said tanks and having camming surfaces in the path of said actuating arm;

d. said camming surface on said target member being shaped to engage and move said arm to actuate said limit switch in both directions of travel and having a cam length along the path of travel proportioned to the stopping distance of said air motor from each direction whereby said trolley frame is stopped at the same position relative to each process tank.

5. A material handling system in accordance with claim **3** including:

a. means to control said valve means controlling the reciprocation of said second motor whereby the downward movement of said second motor is slowed during the placement of said cylindrical housings in said tanks.

6. A material handling system in accordance with claim **1** in which:

a. said first motor means comprises an air motor connected to a chain lift attached to said carriage;

b. said carriage comprises a horizontal support beam affixed at substantially its midpoint to said chain lift;

c. cross members on the ends of said support beam;

d. vertically spaced roller guides on the ends of said cross members engaging said trolley frame; and

e. a downward depending catch member with a lateral offset on said cross member, said offset being adapted to engage said container.

7. A material handling system in accordance with claim **6**, in which:

a. said container comprises a housing rotatably mounted in a hanger member;

b. said hanger member has a pair of upstanding offset hook members;

c. said cross member has a pair of downwardly depending catch members movable to a position immediately below said offset hook members in engaging same whereby said container is suspended for movement by said motor means.

8. A material handling system in accordance with claim **7** in which:

a. said hook members and catch members have opposed flat engaging surfaces to prevent pendulation of said container.

9. A material handling system in accordance with claim **6**:

a. said trolley frame has a pair of upright guide members at each end adjacent said hanger member, said guide members being spaced and outwardly tapered at the bottom from each other in the path of said hanger member to align said fixed stub shafts on said means to receive same upon said tanks.

10. A material handling system in accordance with claim **1** including:

a. a movable conveyor means adjacent the last treating tank at a receiving station and adapted to remove said container at the completion of a treating cycle;

b. a pair of microswitches on said trolley frame, one being normally open and controlling the downward cycle of said second motor means, the other being normally closed and bypassing said first proximity switch;

c. a target member on the last of the series of treating tanks in operable relationship with said one microswitch in the downward cycle of said second motor means over said receiving station;

d. a second target member on said conveyor means in operable relationship with said second microswitch whereby the downward movement of said carriage by said second motor means over said conveyor is dependent upon the presence of said conveyor means and said second target member at said receiving station.